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Sung

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(54) **AUTO DOCUMENT FEEDER, SCANNER INCLUDING THE SAME, AND METHOD OF CONTROLLING AUTO DOCUMENT FEEDING**

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(51) **Int. Cl.**

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B65H 7/18	(2006.01)
H04N 1/00	(2006.01)
B65H 7/14	(2006.01)
B65H 7/20	(2006.01)

(52) **U.S. Cl.**

CPC .. ***B65H 7/06*** (2013.01); ***B65H 7/14*** (2013.01); ***B65H 7/20*** (2013.01); ***H04N 1/00652*** (2013.01)

(58) **Field of Classification Search**

CPC B65H 7/06; B65H 7/18; B65H 7/02; B65H 7/20; B65H 2511/514; B65H 2513/10; H04N 1/0057; H04N 1/00745; H04N 1/00774; H04N 1/00779; H04N 1/00793; H04N 1/00785

See application file for complete search history.

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(57) **ABSTRACT**

Provided are an auto document feeder (ADF), a scanner including the ADF, and a method of controlling auto document feeding. The ADF includes: a feed unit picking up a sheet of paper and carrying the sheet of paper to a scan unit; a feed control unit controlling the feed unit; and a retry control unit. If a sheet of paper is not normally picked up by the feed unit, the retry control unit decreases a speed of a motor driving the feed unit or increases a current supplied to the motor for picking up the sheet of paper. Therefore, although sheets of paper are not normally fed when a user intends to use various kinds of sheets of paper with the ADF, the retry control unit may stabilize feeding of the feeding of the sheets of paper. Thus, efficient, convenient, and high-quality paper feeding may be possible.

20 Claims, 11 Drawing Sheets

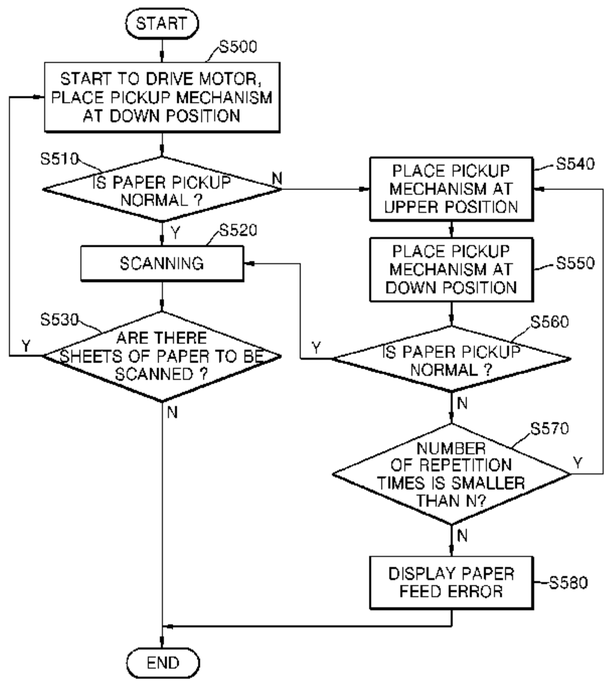

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FIG. 1

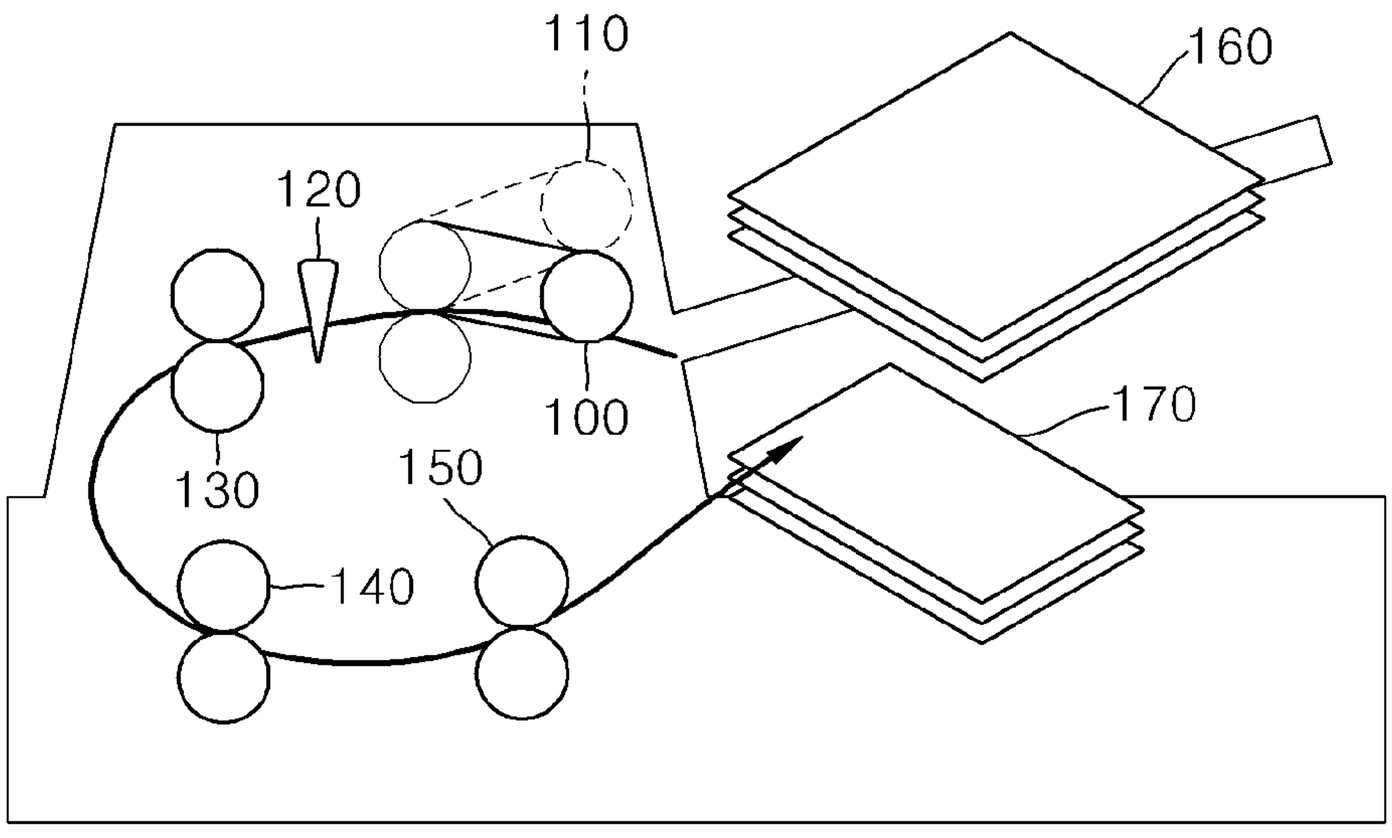

110
160
120
100
170
130
150
140

FIG. 2

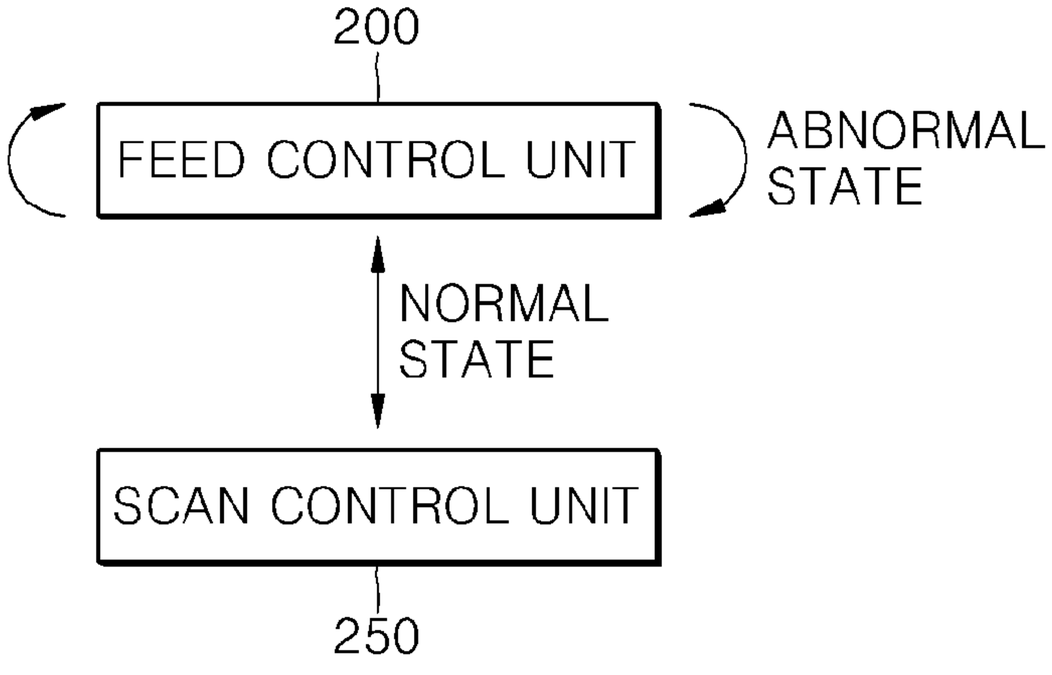

200
FEED CONTROL UNIT
ABNORMAL STATE
NORMAL STATE
SCAN CONTROL UNIT
250

FIG. 3

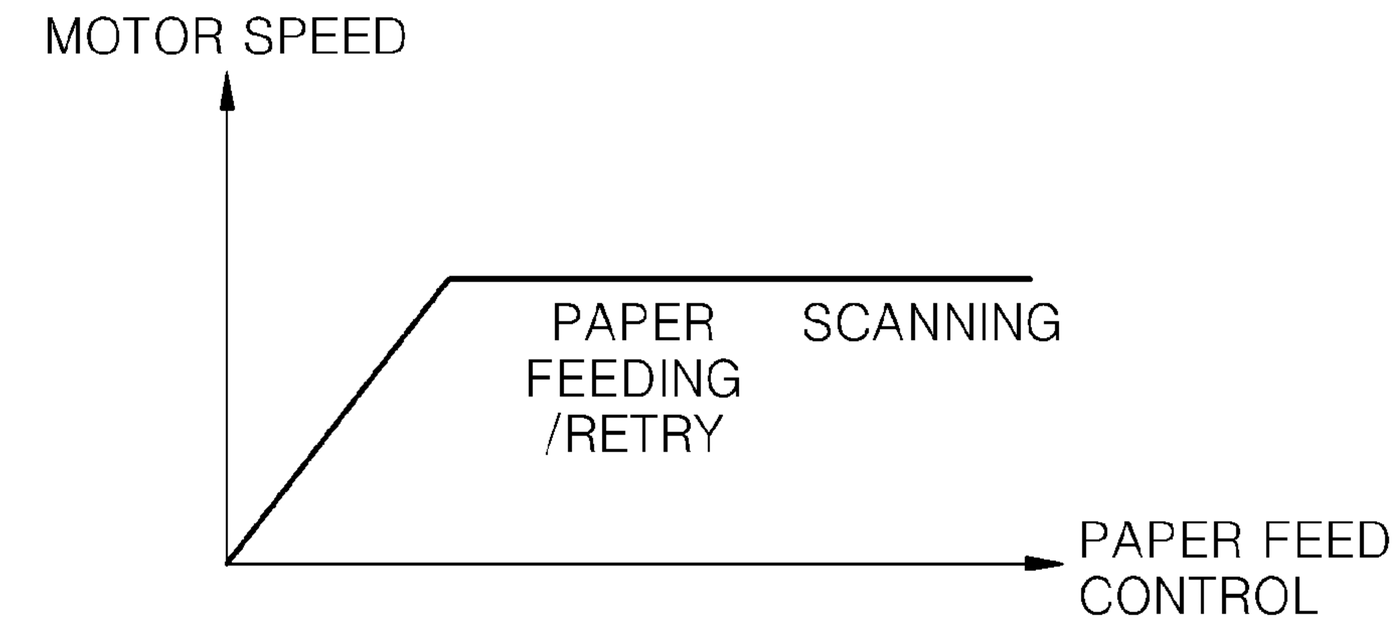

MOTOR SPEED
PAPER FEEDING /RETRY
SCANNING
PAPER FEED CONTROL

FIG. 4

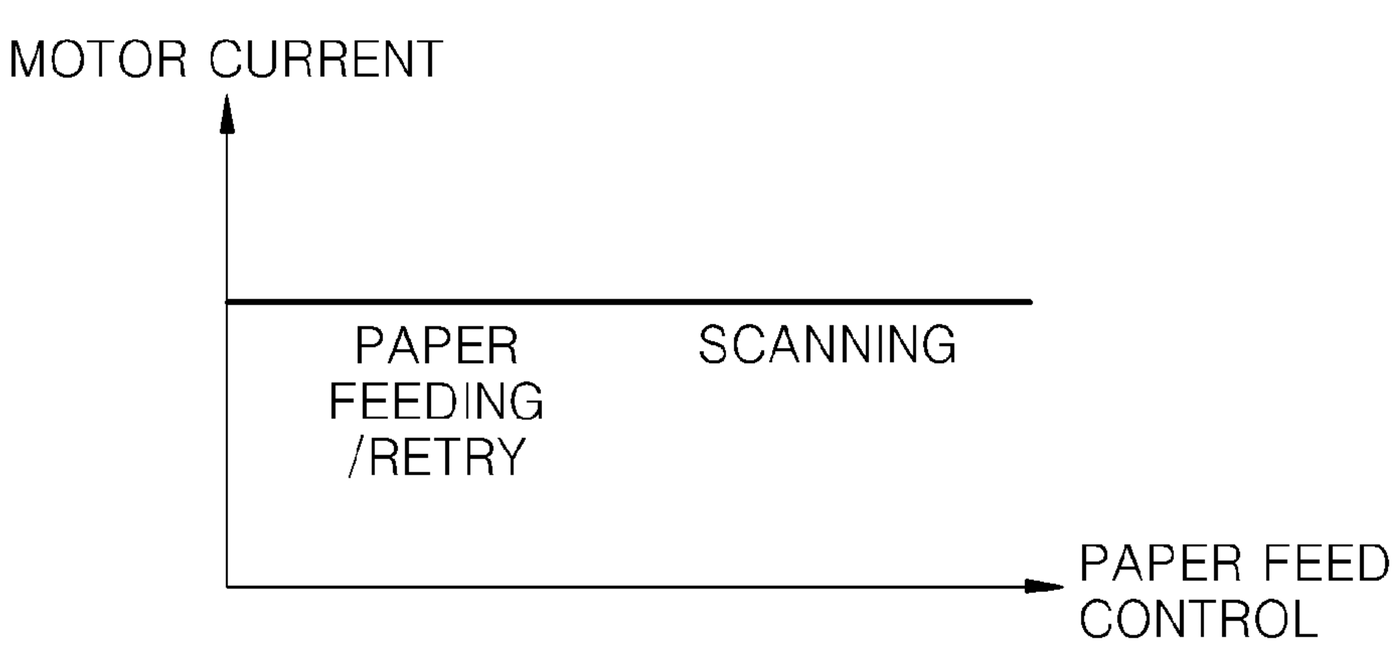

MOTOR CURRENT
PAPER FEEDING /RETRY
SCANNING
PAPER FEED CONTROL

FIG. 5

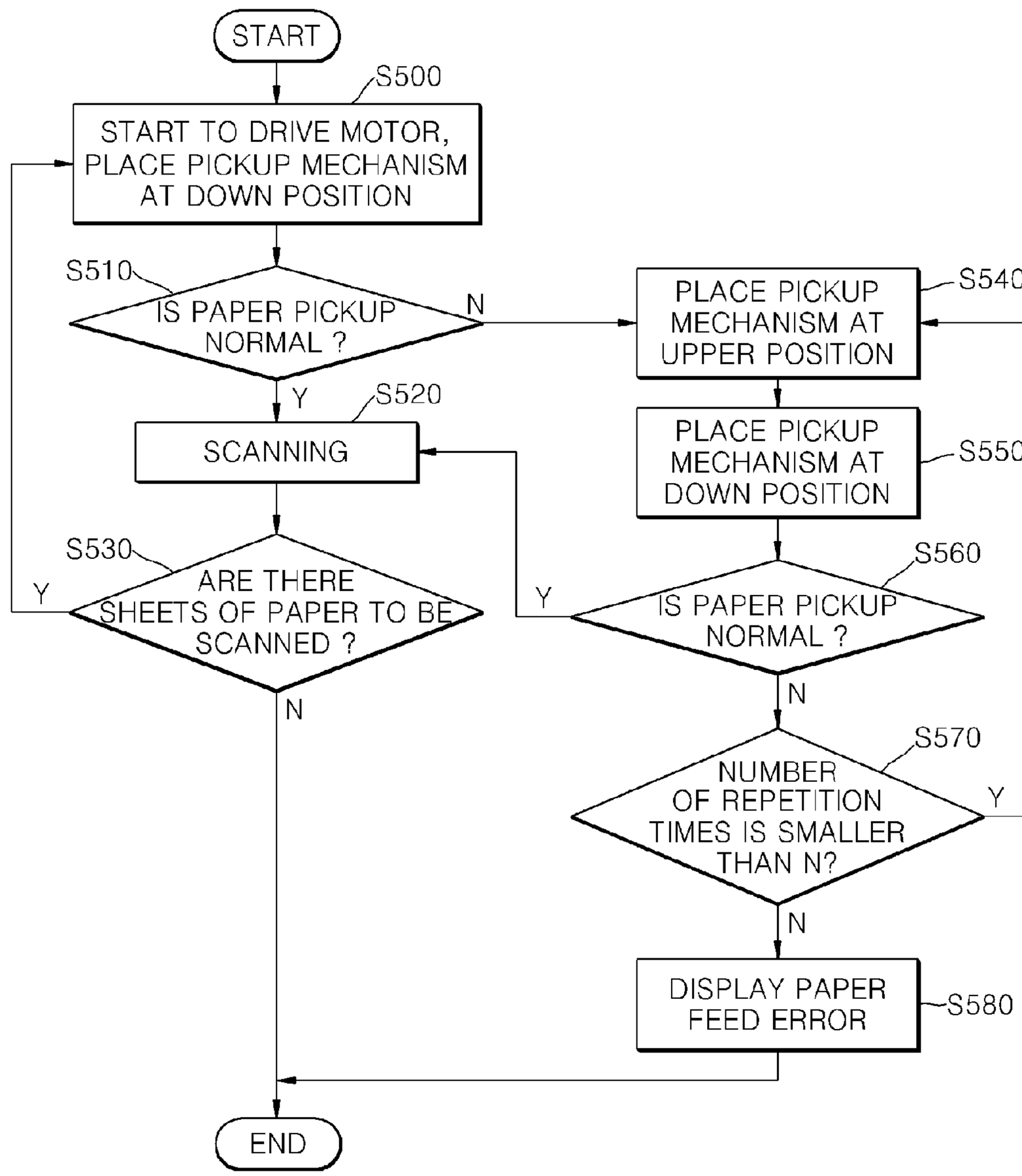

START
S500
START TO DRIVE MOTOR, PLACE PICKUP MECHANISM AT DOWN POSITION
S510
IS PAPER PICKUP NORMAL ?
N
Y
S520
SCANNING
S530
ARE THERE SHEETS OF PAPER TO BE SCANNED ?
Y
N
S540
PLACE PICKUP MECHANISM AT UPPER POSITION
S550
PLACE PICKUP MECHANISM AT DOWN POSITION
S560
IS PAPER PICKUP NORMAL ?
Y
N
S570
NUMBER OF REPETITION TIMES IS SMALLER THAN N?
Y
N
S580
DISPLAY PAPER FEED ERROR
END

FIG. 6

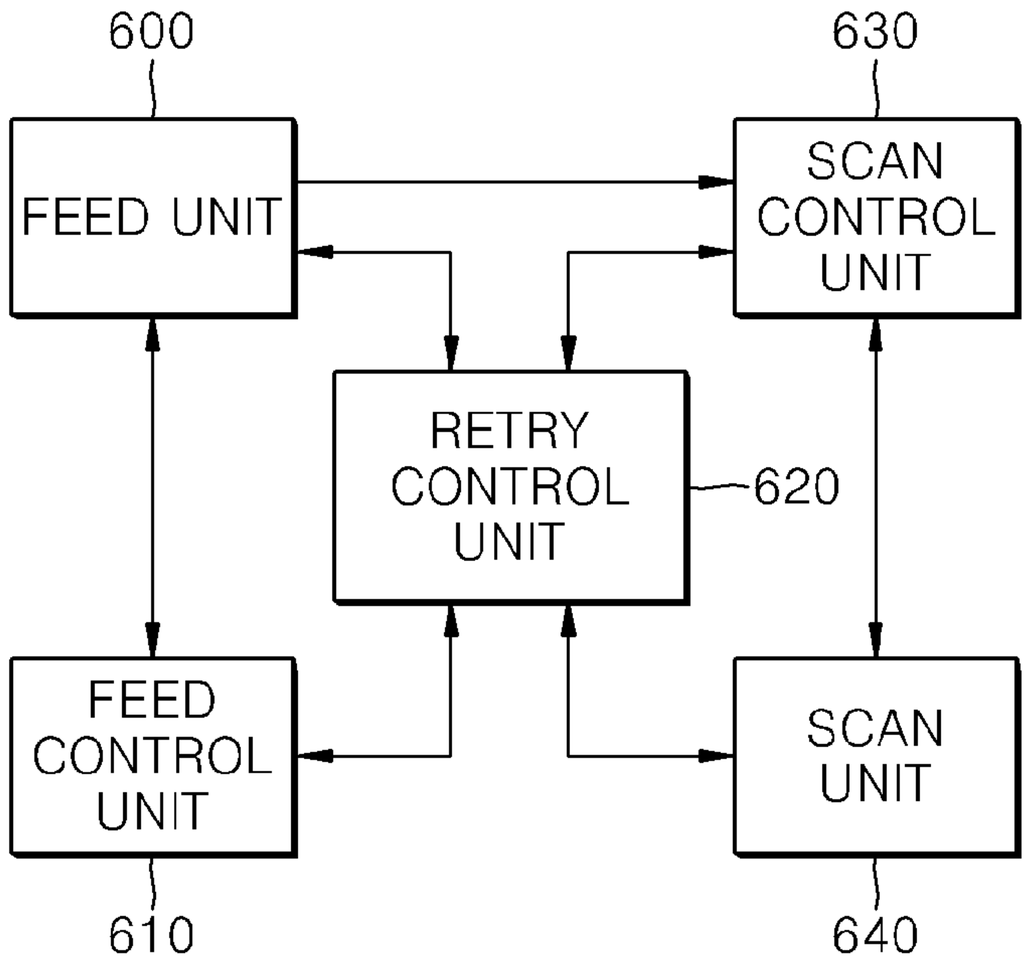

600
630
FEED UNIT
SCAN CONTROL UNIT
RETRY CONTROL UNIT
620
FEED CONTROL UNIT
SCAN UNIT
610
640

FIG. 7

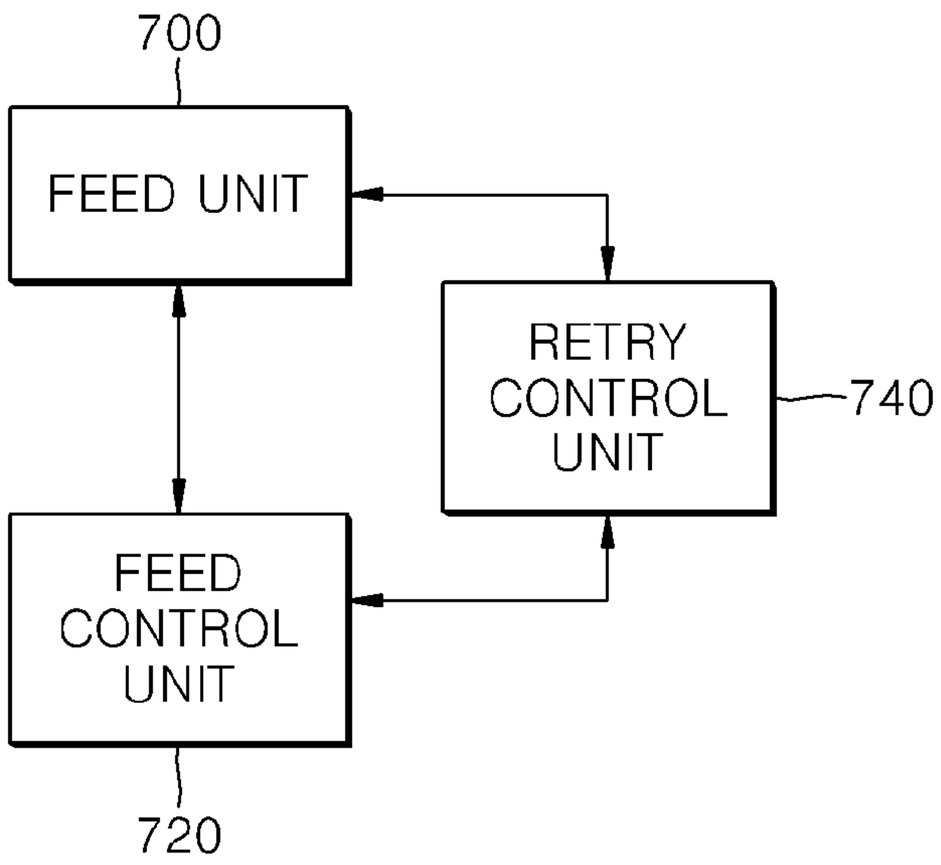

700
FEED UNIT
RETRY CONTROL UNIT
740
FEED CONTROL UNIT
720

FIG. 8

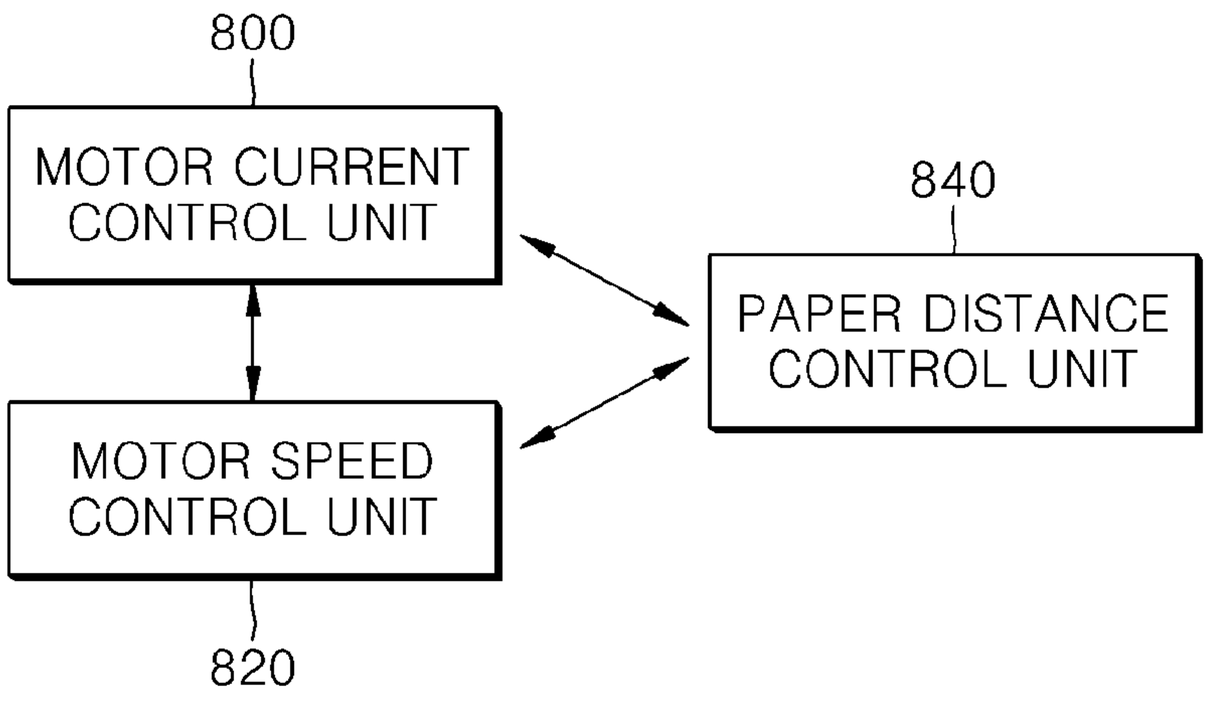

800
MOTOR CURRENT CONTROL UNIT
840
PAPER DISTANCE CONTROL UNIT
MOTOR SPEED CONTROL UNIT
820

FIG. 9

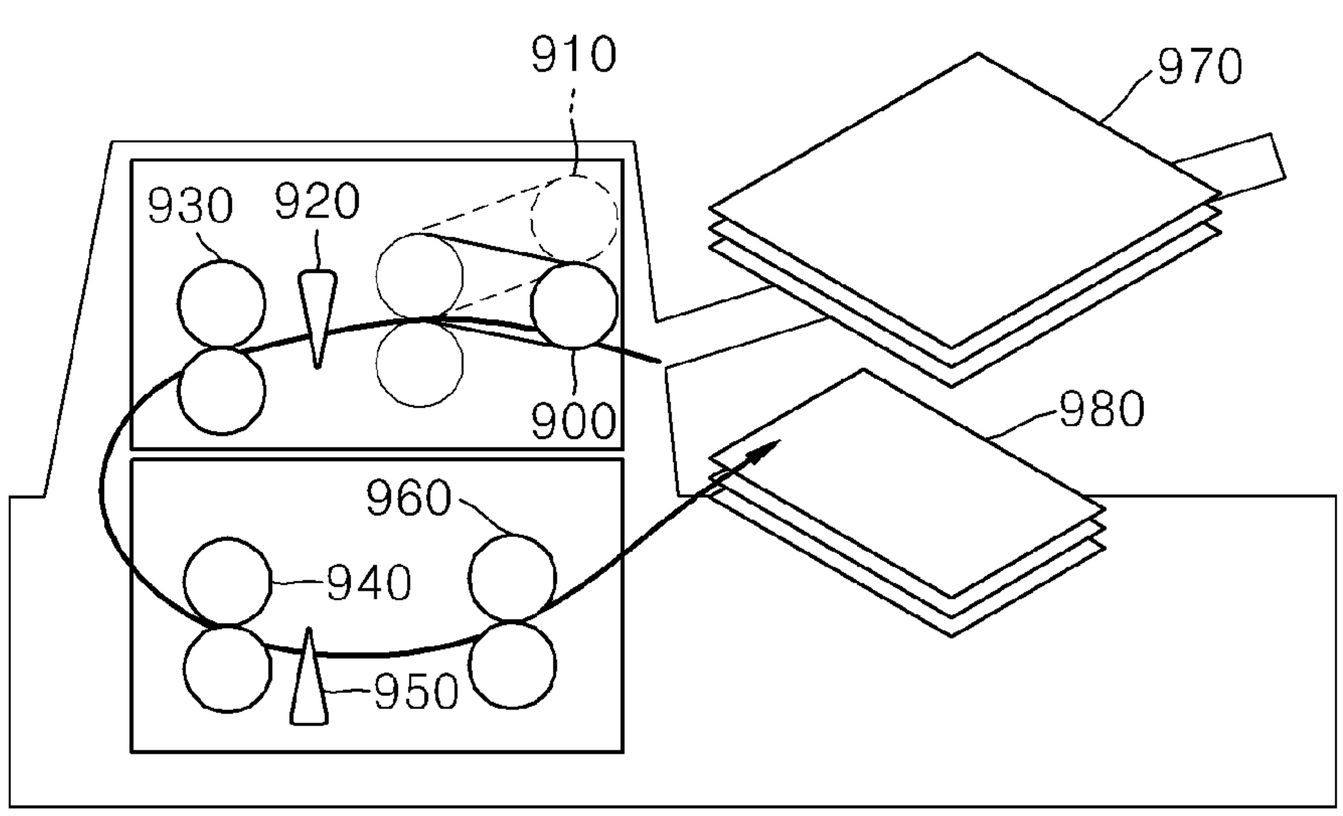

910
970
930
920
900
980
960
940
950

FIG. 10A

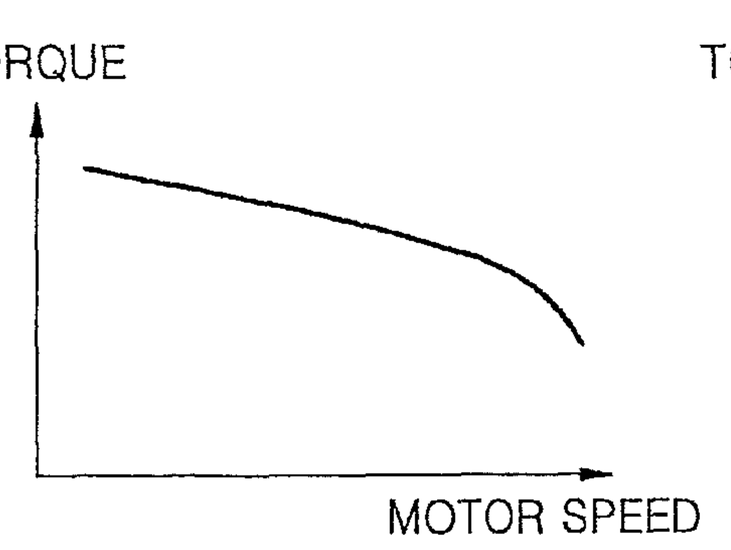


FIG. 10B

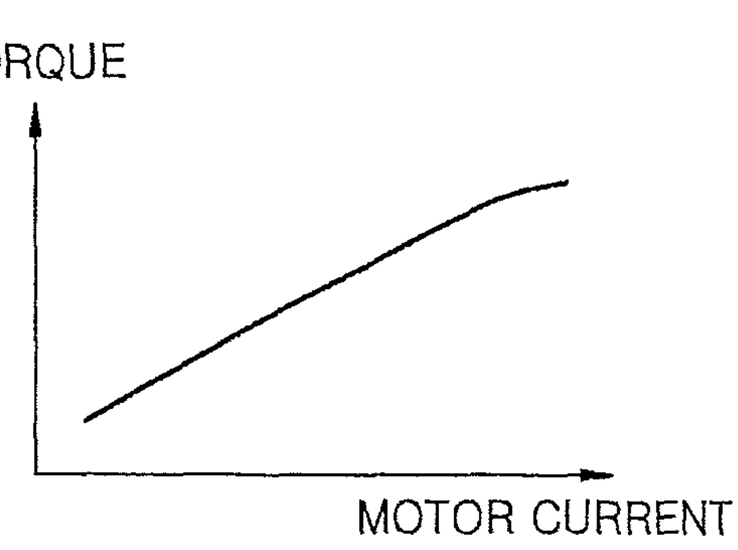


FIG. 11A

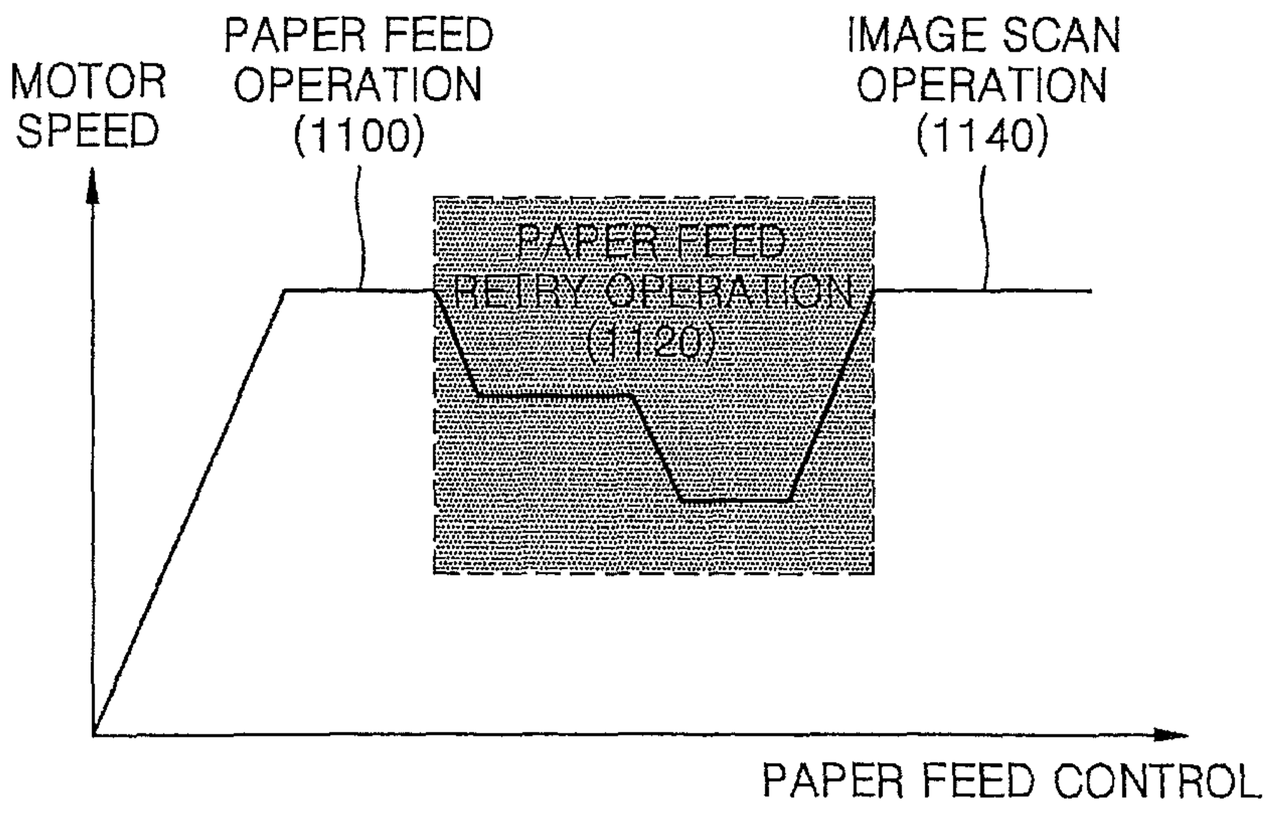


FIG. 11B

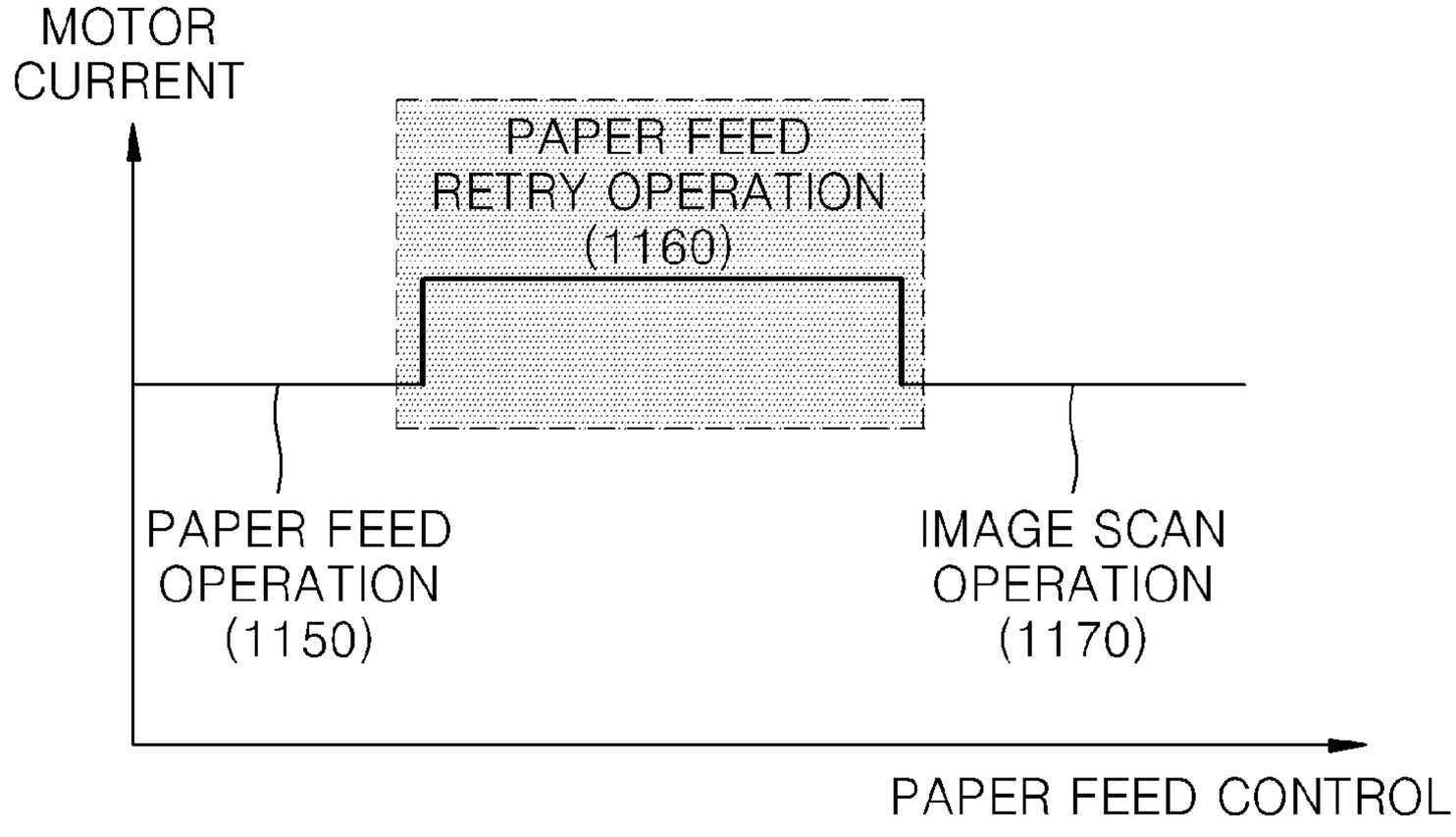


FIG. 12

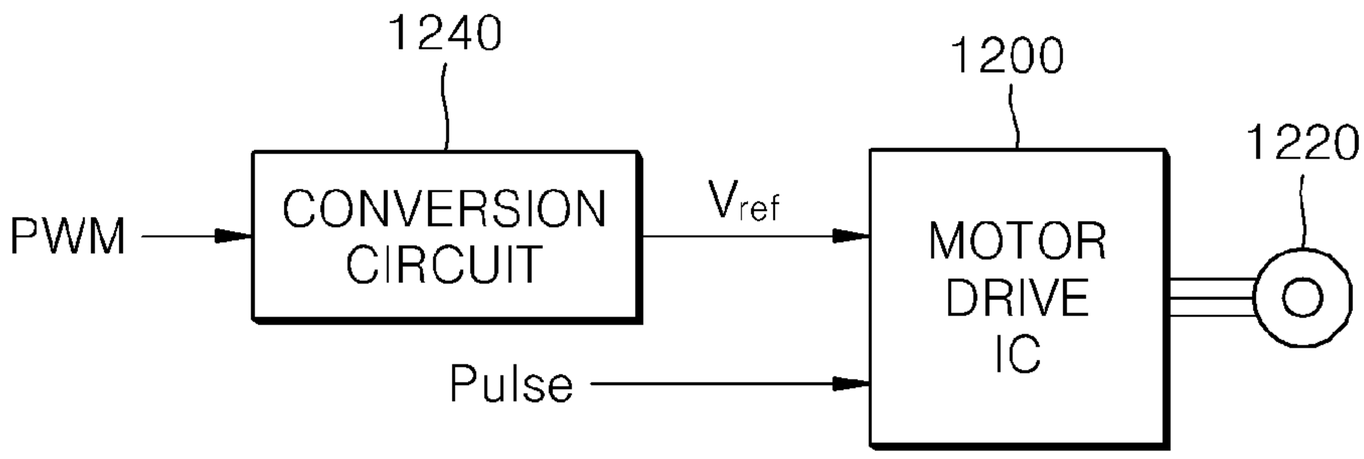


FIG. 13

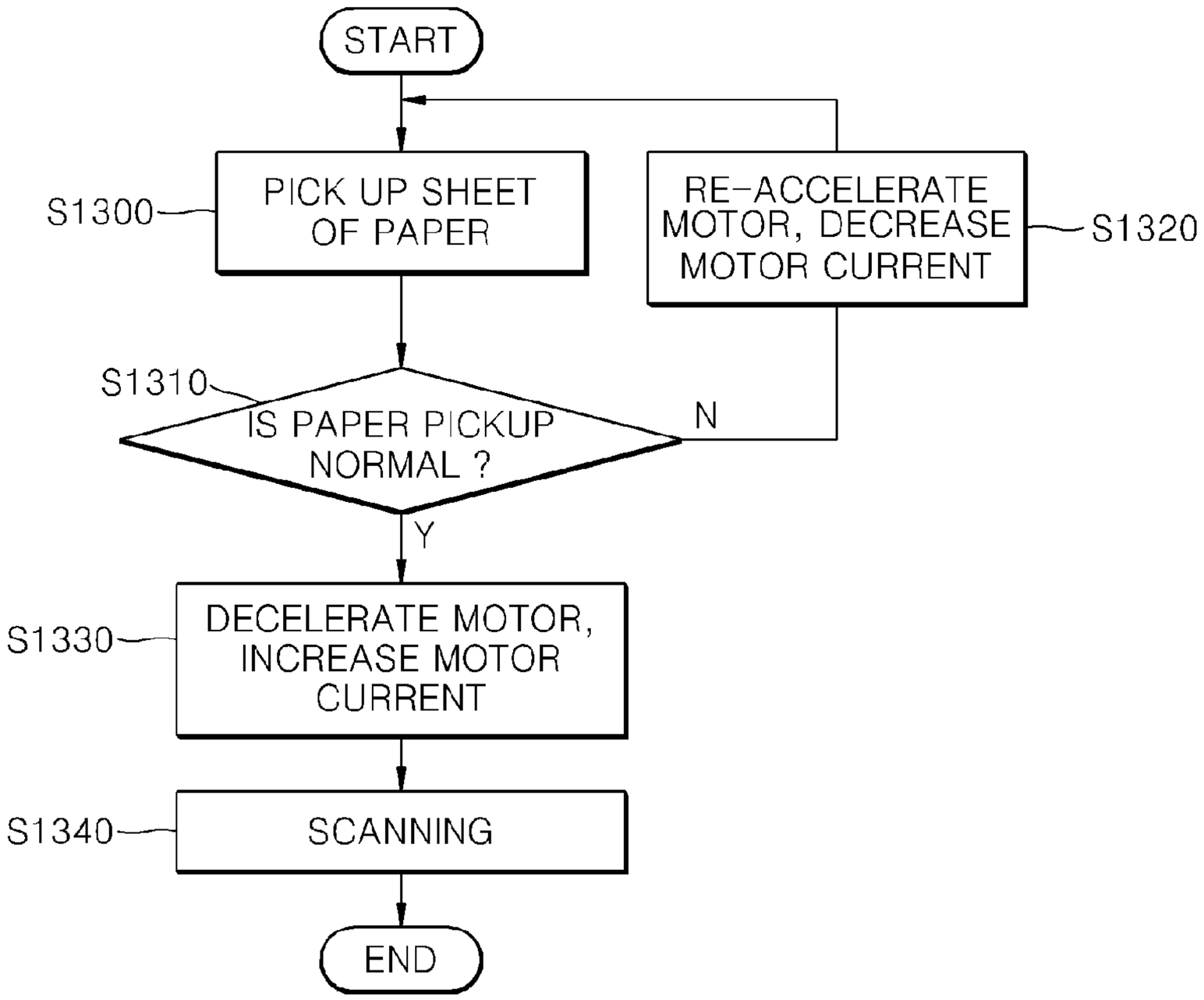

START
S1300
PICK UP SHEET OF PAPER
RE-ACCELERATE MOTOR, DECREASE MOTOR CURRENT
S1320
S1310
IS PAPER PICKUP NORMAL ?
N
Y
S1330
DECELERATE MOTOR, INCREASE MOTOR CURRENT
S1340
SCANNING
END

FIG. 14

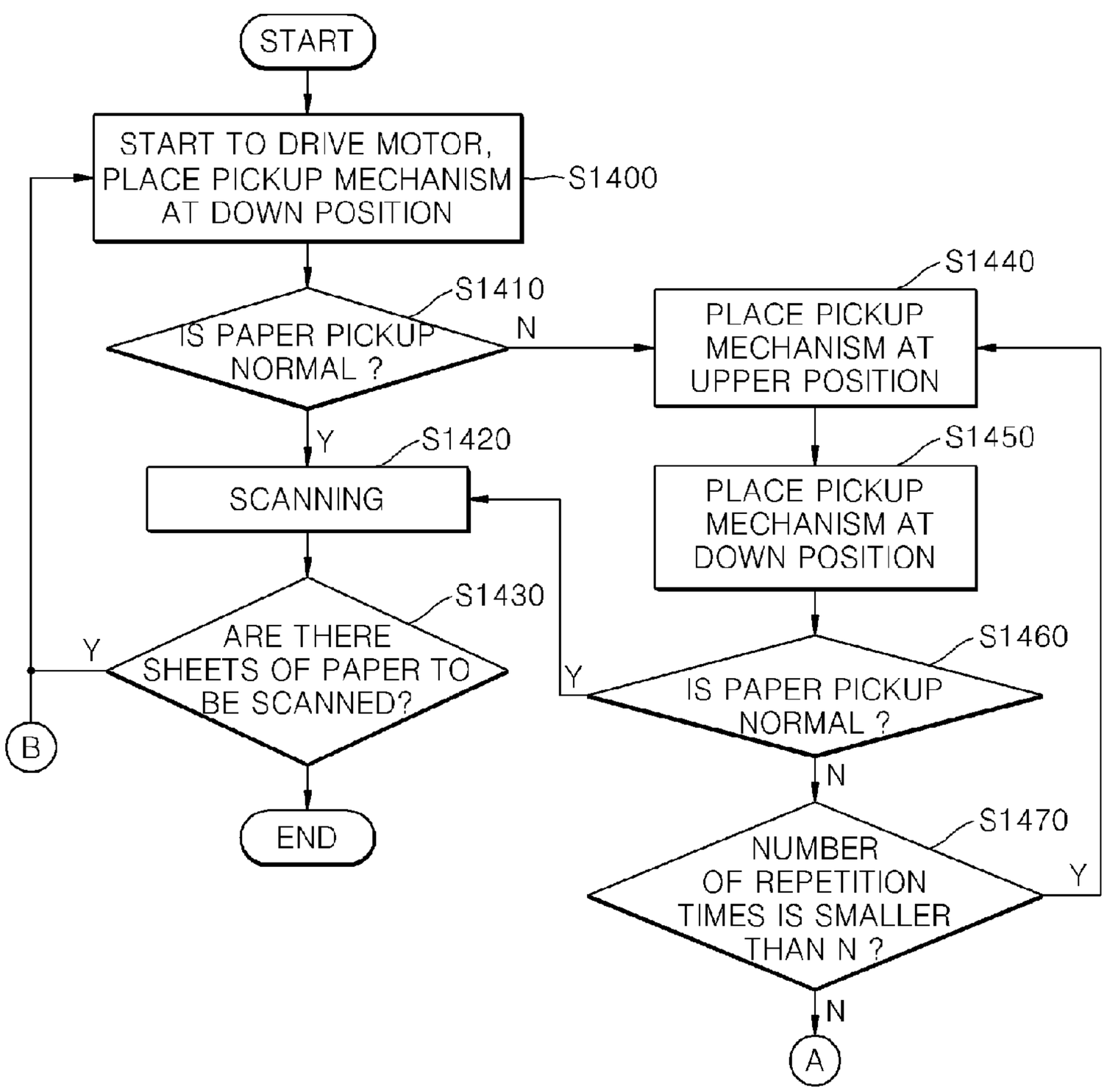

START
START TO DRIVE MOTOR, PLACE PICKUP MECHANISM AT DOWN POSITION
S1400
IS PAPER PICKUP NORMAL ?
S1410
N
Y
S1420
SCANNING
ARE THERE SHEETS OF PAPER TO BE SCANNED?
S1430
Y
B
END
S1440
PLACE PICKUP MECHANISM AT UPPER POSITION
S1450
PLACE PICKUP MECHANISM AT DOWN POSITION
S1460
IS PAPER PICKUP NORMAL ?
Y
N
S1470
NUMBER OF REPETITION TIMES IS SMALLER THAN N ?
Y
N
A

FIG. 15

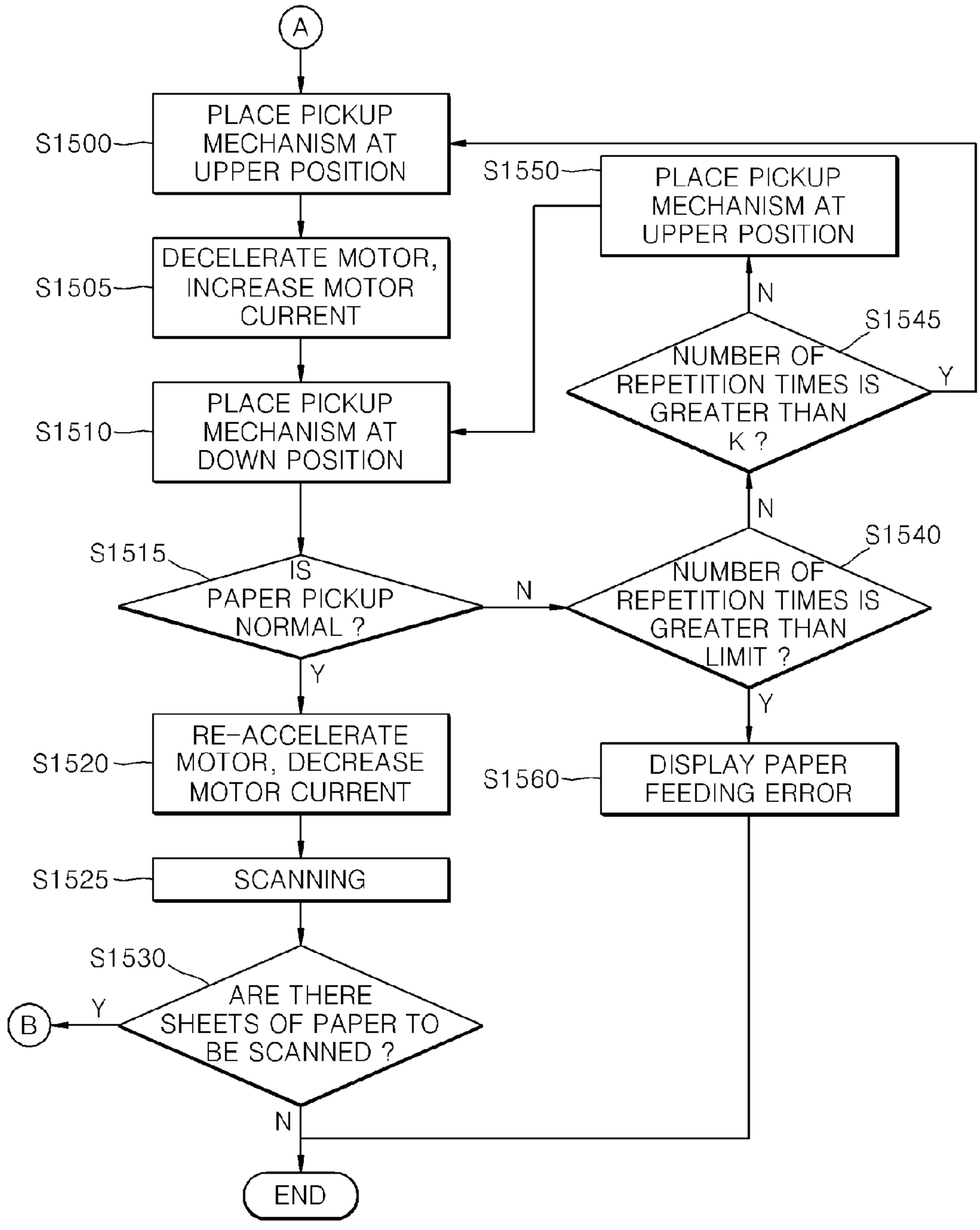
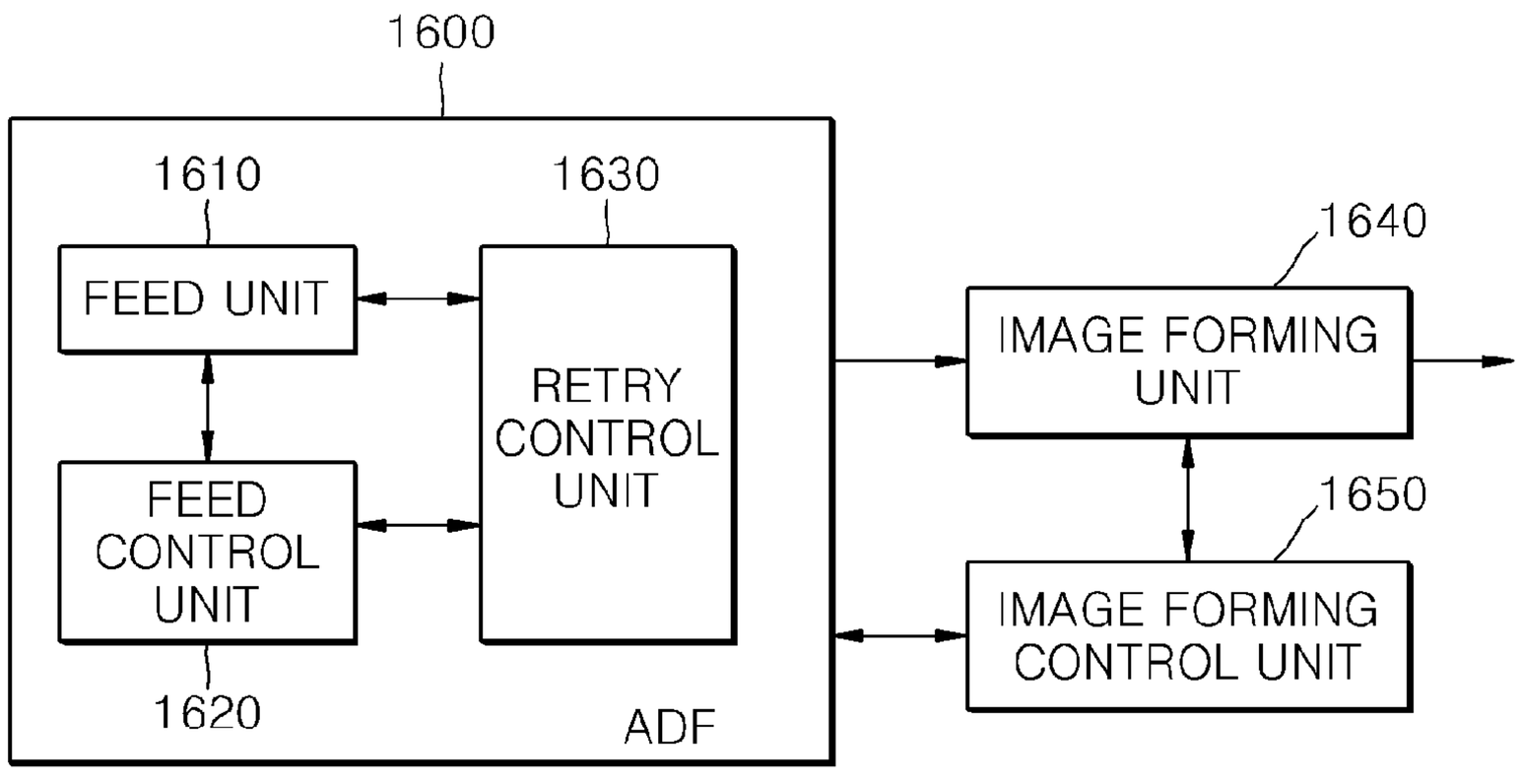

A
S1500
PLACE PICKUP MECHANISM AT UPPER POSITION
S1505
DECELERATE MOTOR, INCREASE MOTOR CURRENT
S1510
PLACE PICKUP MECHANISM AT DOWN POSITION
S1515
IS PAPER PICKUP NORMAL ?
N
Y
S1520
RE-ACCELERATE MOTOR, DECREASE MOTOR CURRENT
S1525
SCANNING
S1530
ARE THERE SHEETS OF PAPER TO BE SCANNED ?
Y
B
N
END
S1540
NUMBER OF REPETITION TIMES IS GREATER THAN LIMIT ?
N
Y
S1545
NUMBER OF REPETITION TIMES IS GREATER THAN K ?
N
Y
S1550
PLACE PICKUP MECHANISM AT UPPER POSITION
S1560
DISPLAY PAPER FEEDING ERROR

FIG. 16


1600
1610
1630
1640
FEED UNIT
RETRY CONTROL UNIT
IMAGE FORMING UNIT
FEED CONTROL UNIT
1650
IMAGE FORMING CONTROL UNIT
1620
ADF

AUTO DOCUMENT FEEDER, SCANNER INCLUDING THE SAME, AND METHOD OF CONTROLLING AUTO DOCUMENT FEEDING

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims the priority benefit of Korean Patent Application No. 10-2013-0082466, filed on Jul. 12, 2013, in the Korean Intellectual Property Office, the disclosure of which is incorporated herein in its entirety by reference.

BACKGROUND

1. Field

One or more embodiments relate to a medium feeder such as a paper feeder, and particularly, to a stable auto document feeder (ADF) capable of normally and stably picking up various kinds of print medium such as various kinds of sheets of paper, and a scanner including the ADF and a method of controlling auto document feeding.

2. Description of the Related Art

Auto document feeders (ADFs) are used to control picking up and feeding of sheets of paper and scanning of images of the sheets of paper. FIG. **1** is a view illustrating a paper feed operation of an ADF. Referring to FIG. **1**, after a sheet of paper is picked up and carried a predetermined distance, a sensor **120** placed along an ADF path generates a turn-on signal, and the next operation is performed.

First, as shown in FIG. **1**, a pickup mechanism is moved to a position **100** adjacent to a paper side for starting a paper pickup operation. After the paper pickup operation, the pickup mechanism is moved back to a position **110** as shown in FIG. **1**. In addition, if the paper pickup operation is repeated, the pickup mechanism is moved away from the paper side.

If the sensor **120** does not generate a turn-on signal, the paper pickup operation is repeated, and if the number of repetition times is equal to or greater than a maximum number of times, an error message is displayed.

FIG. **1** also shows feed rollers **130**, scan rollers **140**, exit rollers **150**, sheets **160**, and sheets **170**.

FIG. **2** is a block diagram illustrating a paper control unit of an ADF. The paper control unit includes a feed control unit **200** and a scan control unit **250**. Referring to FIG. **2**, when paper feeding is normally performed, the feed control unit **200** controls the paper feeding, and then the scan control unit **250** controls image scanning. Before the feed control unit **200** controls paper feeding, the speed of a motor may be increased or decreased, and a current supplied to the motor may be controlled.

If paper feeding is not normally performed, a paper feed operation of the feed control unit **200** may be repeated to normally feed a sheet of paper. If a sheet of paper is not normally fed although the paper feed operation is repeated, an error message is displayed.

FIG. **3** is a graph illustrating how the speed of a paper feed motor is controlled. FIG. **4** is a graph illustrating how a current to the paper feed motor is controlled. Referring to FIGS. **3** and **4**, if a sheet of paper is not normally picked up, a feed control unit repeats a paper feed operation while keeping the speed of the motor at a constant level and supplying a constant current to the motor.

For example, when a user intends to read images of various kinds of sheets of paper (documents) by scanning the sheets

of paper using a paper feeder of an ADF, paper feeding may not be normally performed due to the variety of types of sheets of paper. Then, the paper feeding may be repeatedly performed, and if a sheet of paper is not normally picked up although the paper feeding is performed a maximum number of times, an error message may be displayed. If a sheet of paper is not normally picked up although the paper is performed a maximum number of times, sheets of paper (documents) may not be conveniently scanned and read.

SUMMARY

One or more embodiments include a stable auto document feeder (ADF) for normally and stably picking up various kinds of sheets of paper.

One or more embodiments include a method of controlling paper feeding of an ADF for normally and stably picking up various kinds of sheets of paper.

One or more embodiments include a scanner including an ADF.

One or more embodiments include an image forming apparatus including an ADF.

In an aspect of one or embodiments, there is provided an ADF which includes: a feeder configured to pick up a sheet of paper and carry the sheet of paper to a scanner; a feed controller configured to control the feeder; and a retry controller, wherein if the sheet of paper is not normally picked up by the feeder, the retry controller decreases a speed of a motor driving the feeder or increases a current supplied to the motor for picking up the sheet of paper.

The retry controller may include: a motor current controller configured to vary the current supplied to the motor driving the feeder, wherein if the sheet of paper is not normally picked up by the feeder, the motor current controller may increase the current supplied to the motor; a motor speed controller configured to maintain or vary the speed of the motor, wherein if the sheet of paper is not normally picked up by the feeder, the motor speed controller may decrease the speed of the motor; and a paper distance controller, wherein a paper distance is defined as a distance between a first sensor indicating whether the sheet of paper is normally picked up and a second sensor indicating a start of image scanning, and if the sheet of paper is within the paper distance, the paper distance controller may reduce a current increased and supplied to the motor to a first original value and may increase a decreased speed of the motor to a second original value.

The feeder may include: a pickup roller configured to pick up the sheet of paper; a first sensor indicating whether the sheet of paper is normally picked up; and a feed roller configured to carry the sheet of paper passing the first sensor to the scanner.

In an aspect of one or embodiments, there is provided a scanning apparatus which includes: a scanner configured to scan an image of a sheet of paper; a scan controller configured to control an image scanning operation of the scanner; a feeder configured to pick up a sheet of paper and carry the sheet of paper to the scanner; and a feed controller may be configured to control the feeder; and a retry controller, wherein if the sheet of paper is not normally picked up by the feeder, the retry controller decreases a speed of a motor driving the feeder or increases a current supplied to the motor for picking up the sheet of paper.

The scanning apparatus may include: a scan roller configured to carry a picked-up and carried sheet of paper for a scanning process; a second sensor configured to detect a sheet of paper carried by the scan roller and indicate a start of image

scanning upon detection of the sheet of paper; and an exit roller configured to discharge a sheet of paper passing the second sensor.

The motor may include: a first motor configured to drive the feeder; and a second motor configured to drive the scan unit.

In an aspect of one or more embodiments, there is provided an image forming apparatus which may include: an image forming unit configured to form an image on a sheet of paper; an image forming controller configured to control an image forming operation of the image forming unit; a feeder configured to pick up a sheet of paper and carry the sheet of paper to the image forming unit; a feed controller configured to control the feeder; and a retry controller, wherein if the sheet of paper is not normally picked up by the feeder, the retry controller decreases a speed of a motor driving the feeder or increases a current supplied to the motor for picking up the sheet of paper.

In an aspect of one or more embodiments, there is provided a method of controlling paper feeding in an automatic document feeder (ADF), which includes picking up a sheet of paper; checking whether the sheet of paper is normally picked up; and if the sheet of paper is not normally picked up, retrying to pick up the sheet of paper by decreasing a speed of a motor driving a feeder or increasing a current supplied to the motor.

The checking may be performed by detecting the sheet of paper using a first sensor.

If the sheet of paper is within a paper distance defined from a first sensor indicating whether the sheet of paper is normally picked up to a second sensor indicating a start of image scanning, the method may further include reducing the increased current supplied to the motor to an original value and increasing the decreased speed of the motor to an original value.

If the sheet of paper is not normally picked up, the picking up and the checking may be performed, and if the picking up and the checking are performed more than a preset number of times, the retrying may be performed.

If the sheet of paper is not normally picked up, the retrying may be repeated, and if the retrying is performed more than a preset number of times, a paper feed error may be displayed.

In an aspect of one or more embodiments, there is provided an ADF (auto document feeder) including a feeder configured to pick up a sheet of a medium and carry the sheet to a scanner; and a retry controller, wherein if the sheet is not normally picked up by the feeder, the retry controller decreases a speed of a motor driving the feeder or increases a current supplied to the motor for picking up the sheet.

BRIEF DESCRIPTION OF THE DRAWINGS

These and/or other aspects will become apparent and more readily appreciated from the following description of embodiments, taken in conjunction with the accompanying drawings in which:

FIG. **1** is a view illustrating a paper feed operation of an auto document feeder (ADF);

FIG. **2** is a block diagram illustrating a paper control unit of an ADF;

FIG. **3** is a graph illustrating how the speed of a paper feed motor is controlled;

FIG. **4** is a graph illustrating how a current supplied to the paper feed motor is controlled;

FIG. **5** is a flowchart illustrating a general method of controlling paper feed operations of an ADF;

FIG. **6** is a block diagram illustrating a scanner including an ADF according to an embodiment;

FIG. **7** is a block diagram illustrating an ADF according to an embodiment;

FIG. **8** is a block diagram illustrating a retry control unit according to an embodiment;

FIG. **9** is a view illustrating a scanner including an ADF according to an embodiment;

FIGS. **10**A and **10**B are graphs illustrating general characteristics of a step motor used to drive an ADF;

FIGS. **11**A and **11**B are a graph illustrating an exemplary relationship between the speed of a motor and a paper feed operation, and a graph illustrating an exemplary relationship between a current supplied to the motor and a paper feed operation;

FIG. **12** is a view illustrating an exemplary circuit for controlling a motor speed and a motor current;

FIG. **13** is a flowchart illustrating a method of controlling paper feeding in an ADF according to an embodiment;

FIGS. **14** and **15** are flowcharts illustrating methods of controlling paper feeding in an ADF according to one or more embodiments; and

FIG. **16** is a block diagram illustrating an image forming apparatus including an ADF according to an embodiment.

DETAILED DESCRIPTION

Reference will now be made in detail to embodiments, examples of which are illustrated in the accompanying drawings, wherein like reference numerals refer to like elements throughout. In this regard, embodiments may have different forms and should not be construed as being limited to the descriptions set forth herein. Accordingly, embodiments are merely described below, by referring to the figures, to explain aspects of the present disclosure. As used herein, the term "and/or" includes any and all combinations of one or more of the associated listed items.

Although the term "paper" is used in embodiments, "paper" is an example of a medium which may contain an image to be scanned. The term "paper" is intended as an example and other mediums upon are also contemplated.

FIG. **5** is a flowchart illustrating a general method of controlling paper feed operations of an auto document feeder (ADF). A normal paper feed operation, repetition of a paper feed operation in an abnormal state, and an image scanning control operation are illustrated.

Referring to FIG. **5**, if paper feeding starts, a motor is operated, and a pickup mechanism is placed at a down position (refer to the position **100** in FIG. **1**) (operation S**500**). Then, it is checked whether a sheet of paper is normally picked up by detecting the sheet of paper using a sensor such as the sensor **120** shown in FIG. **1** (operation S**510**).

If it is determined that the sheet of paper is normally detected, a scan control unit (scan controller) such as the scan control unit **250** (scan controller) shown in FIG. **1** is operated to scan an image (operation S**520**). However, if it is determined that the sheet of paper is not normally picked up based on a detection result of the sensor **120**, the pickup mechanism is placed at an upper position (operation S**540**), and is then placed at the down position to pick up the sheet of paper (operation S**550**). Thereafter, it is checked whether the sheet of paper is normally picked up by using the sensor **120** (operation S**560**). If it is determined that the sheet of paper is normally picked up, the scan control unit **250** is operated to scan an image, and if it is determined that the sheet of paper is not normally picked up, operations S**540** to S**560** are repeated a preset maximum number of times N (operation

S570). If the sheet of paper is not picked up after operations S540 to S560 are repeated the present maximum number of times N (operation S570), a paper feed error is displayed (operation S580), and the paper feeding by the ADF is stopped.

If the sheet of paper is normally picked up, the scan control unit **250** scans an image of the sheet of paper, and it is checked whether there remain sheets of paper to be scanned (operation S530). If it is determined that there remain sheets of paper to be scanned, operation S500 is performed. After all sheets of paper are scanned in this way, the paper feeding by the ADF is stopped.

FIGS. **10**A and **10**B are graphs illustrating general characteristics of a step motor used to drive an ADF. FIG. **10**A is a graph illustrating a relationship between torque and speed of the step motor. In a constant current condition, the torque of the step motor decreases as the speed of the step motor increases. That is, as the speed of the step motor decreases, the torque of the step motor increases. FIG. **10**B is a graph illustrating a relationship between torque and current of the step motor. In a constant speed condition, the torque of the step motor increases in proportion to a current supplied to the step motor. That is, if a current to the step motor is decreased, the torque of the step motor is also decreased. Although a current to the step motor is increased, there is an upper limit of torque according to characteristics of the type of the step motor. In one or more embodiments, such torque-current or torque-speed characteristics of a motor are used for stably controlling paper feeding.

For example, a motor having a speed range of about 400 Hz to about 3000 Hz and a current range of about 0.7 A to about 1.4 A (ampere) may be used in one or more embodiments. Specifically, for example, a 1.0-A, 2700-Hz, 124-mNm (milli Newton meter) motor may be used.

Table 1 shows a proportional relationship between torque and current and an inverse-proportional relationship between torque and speed. In Table 1, P7WS and K65WS denote motor types, P.out denotes pull-out torque of a motor measured during operation, and P.in denotes pull-in torque of a motor measured while operating the motor starts from a non-operating state.

TABLE 1

	1.3 A				0.7 A				0.3 A			
	P7WS		K65WS		P7WS		K65WS		P7WS		K65WS	
	P. out	P. in	P. out	P. in	P. out	P. in	P. out	P. in	P. out	P. in	P. out	P. in
200	234.5	204.0	204.0	191.2	108.9	102.0	104.9	92.2	38.2	30.4	32.4	25.5
400	235.2	195.5	202.0	182.4	110.0	83.4	102.0	68.6	36.3		30.4	
600	235.4	164.8	203.0	136.3	113.8		104.0		35.1		33.3	
800	230.5	77.5	205.0		112.8		104.0		33.3		29.4	
1000	224.6		198.1		111.8		100.0		30.4		26.5	
1500	214.8		190.2		106.9		97.1		27.5			
2000	195.2		169.7		101.0		94.1		24.5			
2733	162.0		150.8		96.1		88.3					
3000	152.0		142.3		89.6		86.3					
Hz												mNm

FIG. **6** is a block diagram illustrating a scanner including an ADF according to an embodiment.

FIG. **7** is a is a block diagram illustrating an ADF including a feed unit (feeder) **700**, a feed control unit (feed controller) **720**, and a retry control unit (retry controller) **740** according to an embodiment.

FIG. **8** is a block diagram illustrating the retry control unit **740** according to an embodiment. The retry control unit **740** includes a motor current control unit (motor current controller) **800**, a motor speed control unit (motor speed controller) **820**, and a paper distance control unit (paper distance controller) **840**.

FIG. **9** is a view illustrating the scanner including the ADF according to an embodiment.

With reference to FIGS. **6** to **9**, the ADF and the scanner including the ADF will now be described according to one or more embodiments.

First, the ADF will now be described with reference to FIGS. **6** to **9** according to one or more embodiments. The feed unit **700** picks up a sheet of paper and carries the sheet of paper to a scan unit (scanner) **640**. The feed unit **700** may include a pickup roller (**900**, **910**), a first sensor **920**, and feed rollers **930**.

The pickup roller (**900**, **910**) picks up a sheet of paper **970** on which an image to be scanned is formed. The first sensor **920** detects a picked-up sheet of paper and indicates whether the sheet of paper is normally detected. The first sensor **920** may a registration sensor. The feed rollers **930** carry a sheet of paper passing the first sensor **920**. Registration rollers may be used instead of the feed rollers **930**.

The feed control unit **720** controls the feed unit **700**. Specifically, the feed control unit **720** controls the pickup roller (**900**, **910**) so that the feed unit **700** may pick up a sheet of paper.

If a sheet of paper is not normally picked up by the feed unit **700**, the retry control unit **740** decreases the speed of a motor driving the feed unit **700** or increases a current supplied to the motor for picking up the sheet of paper. Whether a sheet of paper is normally picked up may be determined based on whether the first sensor **920** detects the sheet of paper. If the first sensor **920** detects a sheet of paper, it may be determined that the sheet of paper is normally picked up. If the speed of the motor is decreased and a current supplied to the motor is increased for picking up a sheet of paper, the retry control unit **740** changes the decreased speed of the motor and the increased current supplied to the motor to original values thereof after the sheet of paper is normally picked up and before the scan unit **640** scans an image of the sheet of paper. The reason for this is to match the speed of image scanning with the speed of paper feeding for appropriate image scanning. In addition, if a large current is applied to the motor, the scan unit **640** may be vibrated, and thus image scanning may be affected by the vibration. Therefore, the increased current supplied to the motor may be decreased to an original value thereof. The retry control unit **740** may only decrease the speed of the motor or increase a current supplied to the motor, or may control both the motor speed and current.

FIG. **8** is a block diagram illustrating the retry control unit **740** according to an embodiment. The retry control unit **740** includes the motor current control unit **800**, the motor speed control unit **820**, and the paper distance control unit **840**.

The motor current control unit **800** varies a current supplied to the motor driving the feed unit **700**. If a sheet of paper is not normally picked up by the feed unit **700**, the motor current control unit **800** increases a current supplied to the motor. The motor current control unit **800** may control a current supplied to the motor both in operation and non-operation states of the motor. The motor may be a step motor.

The motor speed control unit **820** maintains or varies the speed of the motor, and if a sheet of paper is not normally picked up by the feed unit **700**, the motor speed control unit **820** decreases the speed of the motor. The motor speed control unit **820** may increase the speed of the motor from a non-operation state. In addition, the motor speed control unit **820** may vary the speed of the motor while the motor is operated.

A paper distance may be defined as a distance between the first sensor **920** indicating whether a sheet of paper is normally picked up and a second sensor **950** indicating a start of image scanning, and if a sheet of paper is within the paper distance, the paper distance control unit **840** may reduce a current increased and supplied to the motor to an original value and may increase a decreased speed of the motor to an original value thereof. If a sheet of paper is picked up through a retry pickup operation in which the speed of the motor is decreased and a current supplied to the motor is increased, the paper distance control unit **840** increases the speed of the motor to an original speed suitable for image scanning after the first sensor **920** is turned on but before the second sensor **950** indicating a start of image scanning is turned on. If image scanning is performed without adjusting the speed of the motor to an original speed for image forming, since the speed of scanning is not matched with the feeding speed of the sheet of paper, an elongated image may be obtained through the image scanning.

FIG. **12** illustrates an exemplary circuit having the functions of the motor current control unit **800** and the motor speed control unit **820**. Referring to FIG. **12**, a signal PWM may be converted into a voltage Vref by a conversion circuit **1240**. That is, the voltage Vref may be changed by varying the signal PWM. The voltage Vref is used as an input signal to a motor drive IC **1200**. That is, a current supplied to a motor **1220** may be increased or decreased by varying the signal PWM. In addition, a pulse signal used as an input signal to the motor drive IC **1200** may be adjusted to vary the speed of the motor **1220**. That is, the speed of the motor **1220** may be adjusted by varying the frequency of the pulse signal. A pulse signal frequency table may be used when varying the frequency of the pulse signal.

Next, with reference to FIGS. **6** to **9**, the scanner including the ADF will now be described according to one or more embodiments.

FIG. **6** is a block diagram illustrating the scanner including the ADF shown in FIG. **7**. The scanner includes the scan unit **640**, a scan control unit (scan controller) **630**, a feed unit (feeder) **600**, a feed control unit (feed controller) **610**, and a retry control unit (retry controller) **620**.

The scan unit **640** scans an image of a sheet of paper. The scan unit **640** includes scan rollers **940**, the second sensor **950**, and exit rollers **960**.

The scan rollers **940** carry a picked-up and carried sheet of paper for a scanning process. The second sensor **950** is used to detect a sheet of paper carried by the scan rollers **940**. If the second sensor **950** detects a sheet of paper carried by the scan rollers **940**, the second sensor **950** indicates a start of image scanning. The exit rollers **960** discharge a sheet of paper **980** passing the second sensor **950**.

The scan control unit **630** controls an image scanning operation of the scan unit **640**.

The feed unit **600** picks up a sheet of paper and carries the sheet of paper to the scan unit **640**. The feed unit **600** is the same as the feed unit **700** shown in FIG. **7** including the pickup roller (**900**, **910**), the first sensor **920**, and the feed rollers **930**. The pickup roller (**900**, **910**) picks up a sheet of paper. The first sensor **920** detects a picked up sheet of paper to determine whether the sheet of paper is normally picked up. The feed rollers **930** carry a sheet of paper passing the first sensor **920** to the scan unit **640**.

The feed control unit **610** controls the feed unit **600**. The feed control unit **610** is the same as the feed control unit **720** of FIG. **7**. That is, the feed control unit **610** controls the feed unit **600**. Specifically, the feed control unit **610** controls the pickup roller (**900**, **910**) so that the feed unit **600** may pick up a sheet of paper.

If a sheet of paper is not normally picked up by the feed unit **600**, the retry control unit **620** decreases the speed of the motor driving the feed unit **600** or increases a current supplied to the motor for picking up the sheet of paper.

The retry control unit **620** is the same as the retry control unit **740** of FIG. **7**. Whether a sheet of paper is normally picked up may be determined based on whether the first sensor **920** detects the sheet of paper. If the first sensor **920** detects a sheet of paper, it may be determined that the sheet of paper is normally picked up. If the speed of the motor is decreased and a current supplied to the motor is increased for picking up a sheet of paper, the retry control unit **620** changes the decreased speed of the motor and the increased current supplied to the motor to original values thereof after the sheet of paper is normally picked up and before the scan unit **640** scans an image of the sheet of paper. The reason for this is to match the speed of image scanning with the speed of paper feeding for appropriate image scanning. In addition, if a large current is applied to the motor, the scan unit **640** may be vibrated, and thus image scanning may be affected by the vibration. Therefore, the increased current supplied to the motor may be decreased to an original value thereof. The retry control unit **620** may only decrease the speed of the motor or increase a current supplied to the motor, or may control both the motor speed and current.

The retry control unit **620** includes the motor current control unit **800**, the motor speed control unit **820**, and the paper distance control unit **840**. Descriptions of the motor current control unit **800**, the motor speed control unit **820**, and the paper distance control unit **840** will not be repeated.

The motor may include a first motor driving the feed unit **600** and a second motor driving the scan unit **640**. Alternatively, the motor drives both the feed unit **600** and the scan unit **640**.

FIG. **16** is a block diagram illustrating an image forming apparatus including an ADF **1600** according to one or more embodiments. The image forming apparatus includes an image forming unit (image forming apparatus) **1640**, an image forming control unit (image forming controller) **1650**, a feed unit (feeder) **1610**, a feed control unit (feed controller) **1620**, and a retry control unit (retry controller) **1630**.

With reference to FIGS. **7**, **8**, and **16**, the image forming apparatus including the ADF **1600** will now be described according to one or more embodiments.

The image forming unit **1640** is used to form images on sheets of paper. The image forming control unit **1650** controls an image forming operation of the image forming unit **1640**.

The feed unit **1610** picks up a sheet of paper by using the pickup roller (**900**, **910**) and carries the sheet of paper to the image forming unit **1640** by using the feed rollers **930**. The feed control unit **1620** controls the feed unit **1610**.

If a sheet of paper is not normally picked up by the feed unit **1610**, the retry control unit **1630** decreases the speed of a motor driving the feed unit **1610** or increases a current supplied to the motor for picking up the sheet of paper.

The retry control unit **1630** has the same functions as the functions of the retry control unit **740** shown in FIG. **7**. If a sheet of paper is not normally picked up by the feed unit **1610**, the retry control unit **1630** decreases the speed of the motor driving the feed unit **1610** or increases a current supplied to the motor for picking up the sheet of paper. Whether a sheet of paper is normally picked up may be determined based on whether the first sensor **920** detects the sheet of paper. If the first sensor **920** detects a sheet of paper, it may be determined that the sheet of paper is normally picked up. If the speed of the motor is decreased and a current supplied to the motor is increased for picking up a sheet of paper, the retry control unit **1630** changes the decreased speed of the motor and the increased current supplied to the motor to original values thereof after the sheet of paper is normally picked up and before the image forming unit **1640** forms an image on the sheet of paper. The reason for this is to match the speed of image forming with the speed of paper feeding for appropriate image forming. In addition, if a large current is applied to the motor, the image forming unit **1640** may be vibrated, and thus image forming may be affected by the vibration. Therefore, the increased current supplied to the motor may be decreased to an original value thereof. The retry control unit **1630** may only decrease the speed of the motor or increase a current supplied to the motor, or may control both the motor speed and current.

The retry control unit **1630** includes the motor current control unit **800**, the motor speed control unit **820**, and the paper distance control unit **840**. The motor current control unit **800** varies a current supplied to the motor driving the feed unit **1610**. If a sheet of paper is not normally picked up by the feed unit **1610**, the motor current control unit **800** increases a current supplied to the motor. The motor speed control unit **820** maintains or varies the speed of the motor, and if a sheet of paper is not normally picked up by the feed unit **1610**, the motor speed control unit **820** decreases the speed of the motor. A paper distance may be defined as a distance between the first sensor **920** indicating whether a sheet of paper is normally picked up and the second sensor **950** indicating a start of image forming, and if a sheet of paper is within the paper distance, the paper distance control unit **840** may decrease a current increased and supplied to the motor to an original value thereof and may increase a decreased speed of the motor to an original value. The image forming apparatus may be an office machine including an ADF, such as a printer, a copy machine, a multi-function apparatus, and a fax machine.

FIG. **13** is a flowchart illustrating a method of controlling paper feeding in an ADF according to an embodiment.

With reference to FIGS. **6** to **9** and **13**, the method of controlling paper feeding in an ADF will now be described according to one or more embodiments.

First, the feed unit **600** picks up a sheet of paper (operation S**1300**). It is checked whether the sheet of paper is normally picked up (operation S**1310**). Whether the sheet of paper is normally picked up may be determined based on whether the sheet of paper is detected by the first sensor **920**.

If it is determined that the sheet of paper is not normally picked up, the motor driving the feed unit **600** is decelerated or a current to the motor is increased (operation S**1320**), and the sheet of paper is picked up again.

Then, it is checked again whether the sheet of paper is normally picked up (operation S**1310**). If it is determined that the sheet of paper is normally picked up, the increased current to the motor and the speed of the motor are changed to original values thereof (operation S**1330**), and the scan unit **640** start scanning (operation S**1340**). That is, in the paper feeding controlling method of the current embodiment, a paper distance may be defined as a distance between the first sensor **920** indicating whether a sheet of paper is normally picked up and the second sensor **950** indicating a start of image forming, and if a sheet of paper is within the paper distance, a current increased and supplied to the motor and a decreased speed of the motor may be changed to original values thereof, and then scanning may be performed.

If the sheet of paper is not normally picked up, operations S**1300** and S**1310** may be performed, and if the operations S**1300** and S**1310** are repeated more than a preset number of times, operation S**1320** may be performed. In addition, if the sheet of paper is not normally picked up, operation S**1320** may be repeated, and if operation S**1310** is repeated more than a preset number of times, a paper feed error may be displayed.

FIGS. **14** and **15** are flowcharts illustrating methods of controlling paper feeding in an ADF according to one or more embodiments.

Referring to FIGS. **14** and **15**, if the ADF is operated, a motor drives a pickup mechanism to a down position (refer to a position **900** shown in FIG. **9**) (operation S**1400**). Then, it is checked whether a sheet of paper is normally picked up by detecting the sheet of paper using a sensor such as the sensor **920** shown in FIG. **1** (operation S**1410**).

If it is determined that the sheet of paper is normally detected, a scan control unit such as the scan control unit **630** shown in FIG. **9** is operated to scan an image (operation S**1420**). However, if it is determined that the sheet of paper is not normally picked up based on a detection result of the sensor **920**, the pickup mechanism is placed at an upper position (operation S**1440**), and is then placed at the down position to pick up the sheet of paper (operation S**1450**). Thereafter, it is checked whether the sheet of paper is normally picked up by using the sensor **920** (operation S**1460**). If it is determined that the sheet of paper is normally detected, the scan control unit **630** is operated to scan an image (operation S**1420**). If the sheet of paper is not normally picked up, operations S**1440** to S**1470** are performed a preset maximum number of times N.

If the sheet of paper is not normally picked up although operations S**1440** to **1470** are repeated the preset maximum number of times N, the pickup mechanism is placed at the upper position (refer to a position **910** shown in FIG. **9**) (operation S**1500**). Then, a retry control unit such as the retry control unit **620** or **740** decreases the speed of a motor driving a feed unit such as the feed unit **600** or **700** or increases a current supplied to the motor so as to increase the torque of the motor for picking up the sheet of paper using a large force (operation S**1505**). Thereafter, the pickup mechanism is placed to the down position (refer to the position **900** shown in FIG. **9**) (operation S**1510**). At this time, both the speed and current of the motor may be controlled. That is, the speed of the motor may be decreased and the current supplied to the motor may be increased.

Thereafter, it is checked whether the sheet of paper is normally picked up by using the first sensor **920** (operation S**1515**). If the sheet of paper is normally picked up and thus the first sensor **920** is turned on, the retry control unit **620** or

740 accelerates the motor to a speed suitable for scanning an image and decreases the current supplied to the motor before the second sensor **950** is turned on (operation S**1520**). Then, the scan unit **640** scans an image of the sheet of paper (operation S**1525**). Thereafter, it is checked whether there remain sheets of paper to be scanned (operation S**1530**), and if it is determined that there remains no sheet of paper to be scanned, the paper feeding by the ADF is stopped. If there remain sheets of paper to be scanned, the method proceeds to operation S**1400** to operate the motor for moving the pickup mechanism to the down position **900**.

If it is determined that the sheet of paper is not normally picked up in operation S**1515**, the method proceeds to operation S**1540** to check whether the number of repetition times is greater than a preset limit. If it is determine that the number of repetition times is greater than the preset limit, a paper feed error is displayed (operation S**1560**), and the method ends. However, if it is determined that the number of repetition times is not greater than the preset limit, the method proceeds to operation S**1545** to check whether the number of repetition times is greater than a preset value K. If the number of repetition times is greater than the preset value K, the method proceeds to operation S**1500** to place the pickup mechanism to the upper position **910**. If the number of repetition times is not greater than the preset value K, the method proceeds to operation S**1550** to place the pickup mechanism to the upper position **910** and then to operation S**1510** to place the pickup mechanism to the down position **900**.

Meanwhile, if it is determined that the sheet of paper is normally picked in operation S**1410**, the scan unit **640** performs scanning (operation S**1420**), and it is checked whether there remain sheets of paper to be scanned (operation S**1430**). If there remain sheets of paper to be scanned, the method proceeds to operation S**1400** for scanning the remaining sheets of paper. If there remains no sheet of paper to be scanned, the method ends.

FIG. **11**A is a graph showing a motor speed control curve for the case in which a sheet of paper is normally picked up after a retry control unit decreases the speed of a motor two times (**1120**) because the number of retry repetition times of paper feeding exceeds a maximum value two times. That is, if a paper feed operation **1100** (paper pickup operation) is not normally performed, a paper feed retry operation is performed. At this time, the speed of the motor is decreased, and since a sheet of paper is not yet normally picked up although the speed of the motor is decreased, the speed of the motor is decreased again.

At this time, as shown in FIG. **11**B, a paper feed operation **1150** is performed, and if a sheet of paper is not normally picked up, a paper feed retry operation is performed after increasing a current supplied to the motor (**1160**). The increased current is decreased to an original value before an image scanning operation **1170** is performed.

As described above, according to the ADF, the method of controlling the ADF, and the scanner including the ADF of one or more embodiments, although sheets of paper are not normally fed when a user intends to use various kinds of sheets of paper with the ADF, the retry control unit may stabilize feeding of the feeding of the sheets of paper. Thus, efficient, convenient, and high-quality paper feeding may be possible.

It should be understood that the exemplary embodiments described therein should be considered in a descriptive sense only and not for purposes of limitation. Descriptions of features or aspects within each embodiment should typically be considered as available for other similar features or aspects in other embodiments.

While embodiments have been described with reference to the figures, it will be understood by those of ordinary skill in the art that various changes in form and details may be made therein without departing from the spirit and scope of the present disclosure as defined by the following claims.

What is claimed is:

1. An ADF (auto document feeder) comprising:

a feeder configured to pick up a sheet of paper and carry the sheet of paper to a scanner;

a feed controller configured to control the feeder; and

a retry controller, wherein if the sheet of paper is not normally picked up by the feeder, the retry controller decreases a speed of a motor driving the feeder and increases a current supplied to the motor for picking up the sheet of paper,

wherein the feeder includes a first sensor and the scanner includes a second sensor, and

wherein if the sheet of paper is within a paper distance defined from the first sensor indicating whether the sheet of paper is normally picked up to the second sensor indicating a start of image scanning, the retry controller reduces the increased current supplied to the motor to a first original value and increases the decreased speed of the motor to a second original value.

2. The ADF of claim **1**, wherein:

the feeder further comprises:

a pickup roller configured to pick up the sheet of paper, and

a feed roller configured to carry the sheet of paper passing the first sensor to the scanner; and

the first sensor indicates whether the sheet of paper is normally picked up.

3. An ADF (auto document feeder) comprising:

a feeder configured to pick up a sheet of paper and carry the sheet of paper to a scanner;

a feed controller configured to control the feeder; and

a retry controller, wherein if the sheet of paper is not normally picked up by the feeder, the retry controller decreases a speed of a motor driving the feeder and increases a current supplied to the motor for picking up the sheet of paper,

wherein the retry controller comprises:

a motor current controller configured to vary the current supplied to the motor driving the feeder, wherein if the sheet of paper is not normally picked up by the feeder, the motor current controller increases the current supplied to the motor;

a motor speed controller configured to maintain or vary the speed of the motor, wherein if the sheet of paper is not normally picked up by the feeder, the motor speed controller decreases the speed of the motor; and

a paper distance controller, wherein a paper distance is defined as a distance between a first sensor indicating whether the sheet of paper is normally picked up and a second sensor indicating a start of image scanning, and wherein if the sheet of paper is within the paper distance, the paper distance controller reduces the current increased and supplied to the motor to a first original value and increases the decreased speed of the motor to a second original value.

4. The ADF of claim **3**, wherein the paper distance controller reduces the current increased and supplied to the motor to the first original value and increases the decreased speed of the motor to the second original value before the scanner scans the image of the sheet of paper.

5. A scanning apparatus comprising:
a scanner configured to scan an image of a sheet of paper;
a scan controller configured to control an image scanning operation of the scanner;
a feeder configured to pick up the sheet of paper and carry the sheet of paper to the scanner;
a feed controller configured to control the feeder; and
a retry controller, wherein if the sheet of paper is not normally picked up by the feeder, the retry controller decreases a speed of a motor driving the feeder and increases a current supplied to the motor for picking up the sheet of paper,
wherein the feeder includes a first sensor and the scanner includes a second sensor, and
wherein if the sheet of paper is within a paper distance defined from the first sensor indicating whether the sheet of paper is normally picked up to the second sensor indicating a start of image scanning, the retry controller reduces the increased current supplied to the motor to a first original value and increases the decreased speed of the motor to a second original value.

6. The scanning apparatus of claim 5, wherein:
the feeder further comprises:
a pickup roller configured to pick up the sheet of paper, and
a feed roller configured to carry the sheet of paper passing the first sensor to the scanner; and
the first sensor indicates whether the sheet of paper is normally picked up.

7. The scanning apparatus of claim 5, wherein:
the scanner comprises:
a scan roller configured to carry picked-up sheet of paper for a scanning process, and
an exit roller configured to discharge the sheet of paper passing the second sensor; and
the second sensor is configured to detect the sheet of paper carried by the scan roller and to indicate a start of image scanning upon detection of the sheet of paper.

8. The scanning apparatus of claim 5, wherein the motor comprises:
a first motor configured to drive the feeder; and
a second motor configured to drive the scanner.

9. A scanning apparatus comprising:
a scanner configured to scan an image of a sheet of paper;
a scan controller configured to control an image scanning operation of the scanner;
a feeder configured to pick up the sheet of paper and carry the sheet of paper to the scanner;
a feed controller configured to control the feeder; and
a retry controller, wherein if the sheet of paper is not normally picked up by the feeder, the retry controller decreases a speed of a motor driving the feeder-e-r and increases a current supplied to the motor for picking up the sheet of paper,
wherein the retry controller comprises:
a motor current controller configured to vary the current supplied to the motor driving the feeder, wherein if the sheet of paper is not normally picked up by the feeder, the motor current controller increases the current supplied to the motor;
a motor speed controller configured to maintain or vary the speed of the motor, wherein if the sheet of paper is not normally picked up by the feeder, the motor speed controller decreases the speed of the motor; and
a paper distance controller, wherein a paper distance is a distance between a first sensor indicating whether the sheet of paper is normally picked up and a second sensor indicating a start of image scanning, and if the sheet of paper is within the paper distance, the paper distance controller reduces the current increased and supplied to the motor to a first original value and increases the decreased speed of the motor to a second original value.

10. The scanning apparatus of claim 9, wherein the paper distance controller reduces the current increased and supplied to the motor to the first original value and increases the decreased speed of the motor to the second original value before the scanner scans the image of the sheet of paper.

11. An image forming apparatus comprising:
an image forming unit configured to form an image on a sheet of paper;
an image forming controller configured to control an image forming operation of the image forming unit;
a feeder configured to pick up the sheet of paper and carry the sheet of paper to the image forming unit by way of a scanner;
a feed controller configured to control the feeder; and
a retry controller, wherein if the sheet of paper is not normally picked up by the feeder, the retry controller decreases a speed of a motor driving the feeder and increases a current supplied to the motor for picking up the sheet of paper,
wherein the feeder includes a first sensor and the scanner includes a second sensor, and
wherein if the sheet of paper is within a paper distance defined from the first sensor indicating whether the sheet of paper is normally picked up to the second sensor indicating a start of image scanning, the retry controller reduces the increased current supplied to the motor to a first original value and increases the decreased speed of the motor to a second original value.

12. An image forming apparatus comprising:
an image forming unit configured to form an image on a sheet of paper;
an image forming controller configured to control an image forming operation of the image forming unit;
a feeder configured to pick up the sheet of paper and carry the sheet of paper to the image forming unit;
a feed controller configured to control the feeder; and
a retry controller, wherein if the sheet of paper is not normally picked up by the feeder, the retry controller decreases a speed of a motor driving the feeder and increases a current supplied to the motor for picking up the sheet of paper,
wherein the retry controller comprises:
a motor current controller configured to vary the current supplied to the motor driving the feeder, wherein if the sheet of paper is not normally picked up by the feeder, the motor current controller increases the current supplied to the motor;
a motor speed controller configured to maintain or vary the speed of the motor, wherein if the sheet of paper is not normally picked up by the feeder, the motor speed controller decreases the speed of the motor; and
a paper distance controller, wherein a paper distance is a distance between a first sensor indicating whether the sheet of paper is normally picked up and a second sensor indicating a start of image scanning, and if the sheet of paper is within the paper distance, the paper distance controller reduces the current increased and supplied to the motor to a first original value and increases the decreased speed of the motor to a second original value.

13. The image forming apparatus of claim 12, wherein the paper distance controller reduces the current increased and supplied to the motor to the first original value and increases

the decreased speed of the motor to the second original value before the scanner scans the image of the sheet of paper.

14. A method of controlling paper feeding in an automatic document feeder (ADF), the method comprising:

picking up a sheet of paper;

checking whether the sheet of paper is normally picked up; and

if the sheet of paper is not normally picked up, retrying to pick up the sheet of paper by decreasing a speed of a motor driving a feeder and increasing a current supplied to the motor,

wherein if the sheet of paper is within a paper distance defined from a first sensor indicating whether the sheet of paper is normally picked up to a second sensor indicating a start of image scanning, the method further comprises reducing the increased current supplied to the motor to a first original value and increasing the decreased speed of the motor to a second original value.

15. The method of claim **14**, wherein the reducing the increased current supplied to the motor to a first original value and the increasing the decreased speed of the motor to a second original value are performed before the start of image scanning.

16. A method of controlling paper feeding in an automatic document feeder (ADF), the method comprising:

picking up a sheet of paper;

checking whether the sheet of paper is normally picked up; and

if the sheet of paper is not normally picked up, retrying to pick up the sheet of paper by decreasing a speed of a motor driving a feeder and increasing a current supplied to the motor,

wherein if the sheet of paper is not normally picked up, the picking up and the checking are performed, and wherein if the picking up and the checking are performed more than a preset number of times, the retrying is performed.

17. The method of claim **16**, wherein if the sheet of paper is not normally picked up, the retrying is repeated, and wherein if the retrying is performed more than a preset number of times, a paper feed error is displayed.

18. An ADF (auto document feeder) comprising:

a feeder configured to pick up a sheet of a medium and carry the sheet to a scanner; and

a retry controller, wherein if the sheet is not normally picked up by the feeder, the retry controller decreases a speed of a motor driving the feeder and increases a current supplied to the motor for picking up the sheet,

wherein the feeder includes a first sensor and the scanner includes a second sensor, and

wherein if the sheet of paper is within a paper distance defined from the first sensor indicating whether the sheet of paper is normally picked up to the second sensor indicating a start of image scanning, the retry controller reduces the increased current supplied to the motor to a first original value and increases the decreased speed of the motor to a second original value.

19. An ADF (auto document feeder) comprising:

a feeder configured to pick up a sheet of a medium and carry the sheet to a scanner; and

a retry controller, wherein if the sheet is not normally picked up by the feeder, the retry controller decreases a speed of a motor driving the feeder and increases a current supplied to the motor for picking up the sheet,

wherein the retry controller comprises a medium distance controller, wherein a medium distance is defined as a distance between a first sensor indicating whether the sheet is normally picked up and a second sensor indicating a start of image scanning, and wherein if the sheet is within the medium distance, the medium distance controller reduces the current increased and supplied to the motor to a first original value and increases the decreased speed of the motor to a second original value.

20. The ADF of claim **19**, wherein the medium distance controller reduces the increased current supplied to the motor to a first original value and increases the decreased speed of the motor to a second original value before the start of image scanning.

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